Replacement Parts and Order Information

Most components listed in this manual are available directly from Actron.

For information on replacement parts, call:

1-800-253-9880

Actron is also available by mail at:

Actron Manufacturing Co.
9999 Walford Ave.
Cleveland, OH 44102

Internet – http://www.actron.com

E-Mail – sunpro@actron.com

actron®

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KAL EQUIP

Professional Sensor Tester/Simulator

INSTRUCTIONS

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Vehicle Service Information

The following publishers have manuals containing diagnostic information for electronic engine control and ignition systems. Contact the publishers for availability and pricing, specifying the make, model and year of your vehicle. Some manuals may be available at auto parts stores or your local public library.

Vehicle Service Manuals

Chilton Book Company
Chilton Way
Radnor, PA 19089

Cordura Publications
Mitchell Manuals, Inc.
Post Office Box 26260
San Diego, CA 92126

Haynes Publications
861 Lawrence Drive
Newbury Park, CA 91320

Motor's Auto Repair Manual
Hearst Company
250 W. 55th Street
New York, NY 10019

Suitable manuals have titles such as:
"Electronic Engine Controls"
"Fuel Injection and Feedback Carburetors"
"Fuel Injection and Electronic Engine Controls"
"Emissions Control Manual"
... or similar titles.

Vehicle Service Manuals from General Motors Corporation

Buick, Cadillac, Chevrolet, GEO, GMC, Oldsmobile & Pontiac
Helm Incorporated
Post Office Box 07130
Detroit, MI 48207

Saturn
Adistra Corporation
c/o Saturn Publications
101 Union Street
Post Office Box 1000
Plymouth, MI 48170

Vehicle Service Manuals from Ford Motor Company (Ford, Lincoln, Mercury)

Ford Publication Dept.
Helm Incorporated
Post Office Box 07150
Detroit, MI 48207

Vehicle Service Manuals from Chrysler Corporation
Chrysler Corporation
Dyment Distribution Service
Post Office Box 360450
Strongsville, OH 44136

Vehicle Service Manuals from Toyota, Honda, Nissan

Toyota Motor Corporation
Toyota Service Publications
750 W. Victoria Street
Compton, CA 90220-5538

Honda Motor Co., Ltd.
Helm Incorporated
Post Office Box 07280
Detroit, MI 48207

Nissan North America, Inc.
Dyment Distribution Service
c/o Nissan
20770 Westwood Drive
Strongsville, OH 44136

General Safety Guidelines to Follow When Working on Vehicles

- Always wear approved eye protection
- Always operate the vehicle in a well-ventilated area. Do not inhale exhaust gases – they are very poisonous!
- Always keep yourself, tools, and test equipment away from all moving or hot engine parts.
- Always make sure the vehicle is in **Park** (automatic transmission) or **Neutral** (manual transmission) and that the parking brake is firmly set. Block the drive wheels.
- Never lay tools on vehicle battery. You may short the terminals together, causing harm to yourself, the tools, or the battery.
- Never smoke or have open flames near vehicle. Vapors from fuel or charging batteries are highly flammable and explosive.
- Never leave vehicle unattended while running tests.
- Always keep a fire extinguisher suitable for all types of fires handy.
- Always turn ignition key OFF when connecting or disconnecting electrical components, unless otherwise instructed.
- Use shop rags to cover fuel line fittings when connecting or disconnecting fuel lines. Avoid contact with fuel. Dispose of all rags properly.
- Clean up all fuel spills immediately.
- Keep away from engine cooling fan. On some vehicles, the fan may start up unexpectedly.
- You must follow vehicle service manual cautions when working around the air bag system. If the cautions are not followed, the air bag may open unexpectedly, resulting in personal injury. Note that the air bag can still open up several minutes after the ignition key is turned OFF (or even if the battery is disconnected) because of a special energy reserve module.
- Always follow vehicle manufacturer's warnings, cautions, and service procedures.

Section 1 – Tester Basics

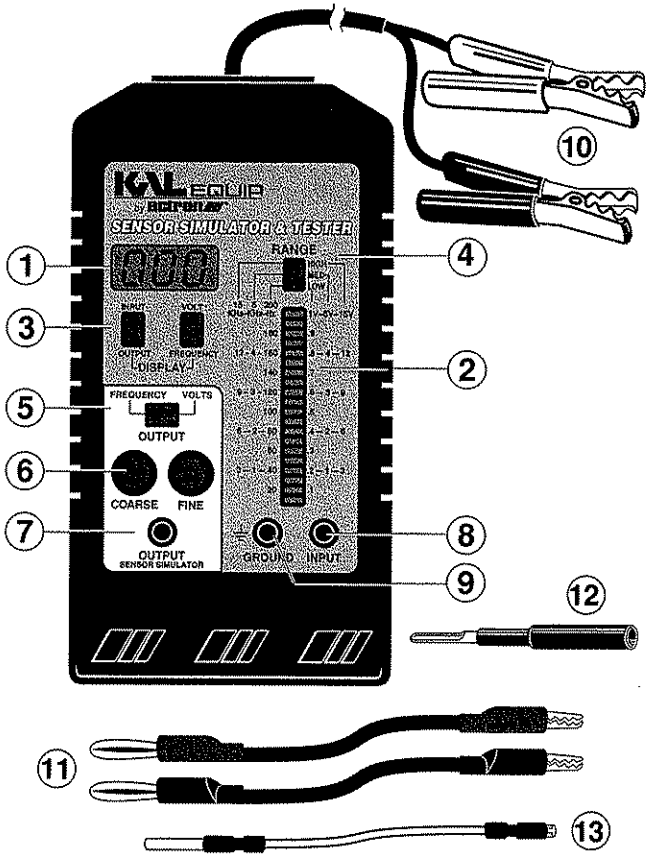
The Model 2994 is a useful tool which can check vehicle sensors as well as simulate sensor signals to test vehicle control systems.

① Numeric Display

Three digit indicator for accurate readings of signals either being measured (INPUT) or sent (OUTPUT) by the tester. The display will blink when signals are too large to be measured (overrange condition). Move the RANGE switch to a higher position to make the measurement.

② Bar Graph Display

Indicates changing signal levels with a moving bar of light traveling up and down the column. This display is only on when measuring INPUT signals. This display is OFF when OUTPUT signals are being measured.



③ DISPLAY switches

These switches select the type of signal measurement being shown.

INPUT - Display shows sensor signals being measured using the tester's INPUT connector.

OUTPUT - Display shows sensor simulation signals being generated at the tester's OUTPUT connector. (Note: The bar graph display is OFF when switch is in OUTPUT position.)

VOLTS - Display shows voltage measurements.

FREQUENCY - Display shows frequency measurements.

④ RANGE switch

This switch has two functions:

— When the DISPLAY switch is on INPUT, the RANGE switch selects the desired input signal measurement range (shown beside the bar graph indicator). The numeric display uses the same range as the bar graph.

LOW - 0 to 1 volt *or* 0 to 200 Hz.

MED - 0 to 5 volts *or* 0 to 5 KHz.

HIGH - 0 to 15 volts *or* 0 to 15 KHz.

— When the DISPLAY switch is on OUTPUT, the RANGE switch is used along with the COARSE and FINE knobs to set the value of the sensor simulator output signal. (Note: The range of sensor simulator output signal is NOT the same as the values shown alongside the bar graph.)

The ranges shown as follows are approximate...

LOW - 0 to 1.25 volt *or* 0 to 160 Hz.

MED - 0 to 2.5 volts *or* 0 to 5 KHz.

HIGH - 0 to 5 volts *or* 0 to 15 KHz.

⑤ OUTPUT switch

Selects the type of sensor simulation signal being generated at the tester's OUTPUT connector.

VOLTS - DC voltage signal is generated.

FREQUENCY - Frequency (squarewave) signal is generated.

⑥ COARSE and FINE knobs

Adjusts the sensor simulator output signal (voltage level or frequency). The range of adjustment is set by the position of the RANGE switch (see RANGE switch description).

COARSE - Coarse adjustment of output signal.

FINE - Fine adjustment of output signal.

⑦ OUTPUT jack

Provides the sensor simulator output signal. The signal is set up using the OUTPUT, RANGE, COARSE and FINE controls (see previous descriptions). The output signal is low power - to protect computer circuits. The output signal cannot energize relays and the like.

⑧ INPUT jack

Receives signals for display on the numeric and bar graph indicators. The measurements are set up using the DISPLAY and RANGE switches.

⑨ GROUND jack

This jack is connected to vehicle ground. DO NOT connect any voltage circuit to this jack - damage will result to tester or circuit. This jack is only used if a ground is necessary for testing.

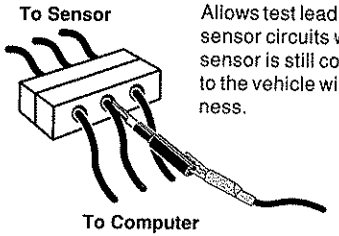
⑩ Power Cable

The tester is powered whenever the power cable is connected to vehicle battery. (Tester has no power on-off switch.)

⑪ Test Leads

Connect tester to sensor or vehicle circuit being checked.

⑫ Backprobe Adapter



Allows test lead to probe sensor circuits while the sensor is still connected to the vehicle wiring harness.

- Slide "scooped" end of adapter next to circuit wire entering rear of connector.
- Continue pushing adapter until it touches terminal inside connector. (Slightly twisting adapter while pushing may ease entry.)
- Grasp open end of adapter wit test lead clip. Keep pushing on adapter to maintain circuit contact.

⑬ Connector Pin Adapters

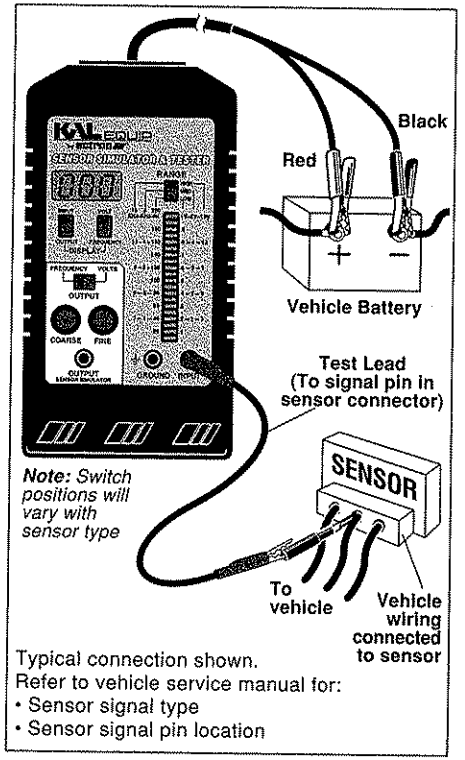
Used, if necessary, when simulating sensor signals - for easier attachment of test lead to wiring connector.

- Push one end of the adapter onto the desired connector pin.
- Grasp the other end with the test lead clip.

Section 2
Basic Sensor Test Hook-Up Procedure

The following is a basic test procedure for checking sensors. Specific sensor types are covered in Section 3, "Sensor Test Procedures".

NOTE: Sensor remains mounted on vehicle and connected to wiring harness for testing.



Typical connection shown.
Refer to vehicle service manual for:
- Sensor signal type
- Sensor signal pin location

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

Red clamp to battery plus terminal and black clamp to battery minus terminal.

3) Plug red test lead into tester INPUT jack.

No other leads are required. (The power cable provides ground for tester measurements.)

4) Set DISPLAY switch to INPUT.

Both numeric and bar graph displays are active.

5) Set other DISPLAY switch to VOLTS or FREQUENCY (depends upon sensor).

Refer to vehicle service manual for correct signal type. Depending upon switch setting, both displays will indicate either voltage or frequency signal levels.

6) Set RANGE switch to proper scale (depends upon sensor).

— Refer to vehicle service manual for signal operating range.

— The numeric display will blink if the signal is too large to measure using the selected range. Simply move RANGE switch to next higher position.

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location. Use backprobe adapter if possible. Otherwise, carefully pierce signal wire for connection. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.

8) Turn ignition key ON (engine OFF).

9) Operate sensor and watch tester displays to verify proper signal action.

Refer to vehicle service manual for correct signal response.

— Check sensor power and ground circuits if sensor signal not operating correctly —

Power and Ground Circuit Checks

Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.

1) Verify:

Sensor connected to vehicle wiring.

Ignition key ON.

Tester power cable connected to vehicle battery.

Red test lead in INPUT jack.

2) Set DISPLAY switches to INPUT and VOLTS.

3) Set RANGE switch to HIGH (15 volt scale).

4) Connect red test lead clip to sensor power pin (if used) - measure voltage.

— Refer to vehicle service manual for power pin location and voltage value.

— Check for wiring problems if voltage is very low, or missing.

5) Set RANGE switch to LOW (1 volt scale).

6) Connect red test lead clip to sensor ground pin (if used) - measure voltage.

— Refer to vehicle service manual for ground pin location.

— A good ground should be less than 0.2 volts.

— If voltage is higher, look for resistance or open in ground circuit.

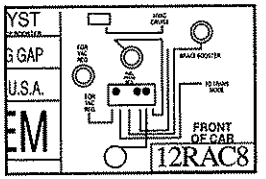
— Some sensors make ground connection by being threaded or bolted to the engine. Check by touching test clip to grounding part of sensor body.

Section 3
Sensor Test Procedures

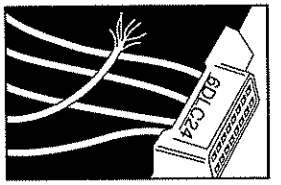
Troubleshooting Tips

Save yourself time! Always begin with a thorough visual and "hands-on" inspection. You can often find the cause of many problems by just looking.

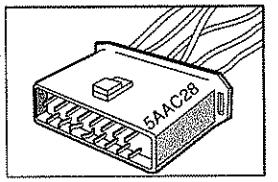
- Has the vehicle been serviced recently? Sometimes things get reconnected in the wrong place, or not at all.
- Don't take shortcuts. Inspect hoses and wiring which may be difficult to see due to location.
- Inspect the air cleaner and ductwork for defects.
- Check sensors and actuators for damage.



- Inspect all vacuum hoses for:
  - Correct routing. Refer to vehicle service manual, or Vehicle Emission Control Information (VECI) decal located in the engine compartment.
  - Pinches and kinks.
  - Splits, cuts or breaks.



- Inspect wiring for:
  - Contact with sharp edges (this happens often).
  - Contact with hot surfaces, such as exhaust manifolds.
  - Pinched, burned or chafed insulation.
  - Proper routing and connections.



- Check electrical connectors for:
  - Corrosion on pins.
  - Bent or damaged pins.
  - Contacts not properly seated in housing.
  - Bad wire crimps to terminals.

Crank/Camshaft Sensor Test

These sensors send frequency (or pulse) type signals to the engine computer indicating the position, or rotating speed, of the crank/camshaft. The signal frequency increases as the rotational speed increases. Used to reference fuel injector operation and synchronize spark plug firing.

There are various sensor types (such as magnetic reluctance, Hall effect and optical).

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to:

— **VOLTS** (Magnetic reluctance type sensor) *or...*

— **FREQUENCY** (Hall effect or optical type sensor).

Refer to vehicle service manual for correct sensor type.

6) Set RANGE switch to proper scale (depends upon sensor).

Try LOW position first - change if necessary.

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Crank or start engine to operate sensor.

9) Verify proper signal action.

• Magnetic reluctance (VOLTS display):

Watch the bar graph. Light should flicker or stay ON during testing. Position and movement of light activity varies with sensor type and engine RPM. No activity could mean a faulty sensor.

• Hall effect or optical (FREQUENCY display):

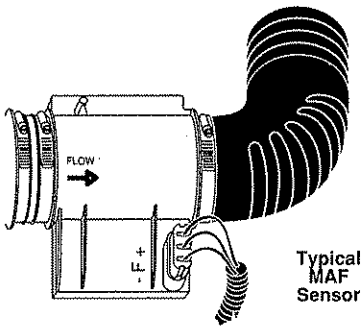
Watch the numeric display. Frequency values are low at idle. As engine RPM is gradually raised, frequency values should increase steadily with no interruption. (Move throttle to check.) Change RANGE switch setting if necessary.

If engine does not start, cranking RPM may be too low to generate a measurable frequency. Switch to VOLTS and test like a magnetic reluctance type.

If signal is not operating correctly....

- *Check sensor power and ground circuits (where used). Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for damaged / misadjusted reluctor ring (or shutter assembly) or foreign material in sensor gap.*

Mass Air Flow (MAF) Sensor Test



Typical MAF Sensor

This sensor sends a signal to the computer indicating the amount of air entering the engine. Depending upon sensor type, the signal may be a dc voltage or a frequency. The signal level increases (higher voltage or frequency) as the air flow increases. Used to control fuel delivery and spark advance.

This sensor uses a "heated wire" element in the air path to measure flow.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to desired signal type (VOLTS or FREQUENCY).

Refer to vehicle service manual for correct sensor signal type.

6) Set RANGE switch to proper scale (depends upon sensor).

Refer to vehicle service manual for correct signal operating range.

Typically, use MED for volts and LOW or MED for frequency - change if necessary.

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Start engine to operate sensor.

9) Watch tester displays to verify proper signal action.

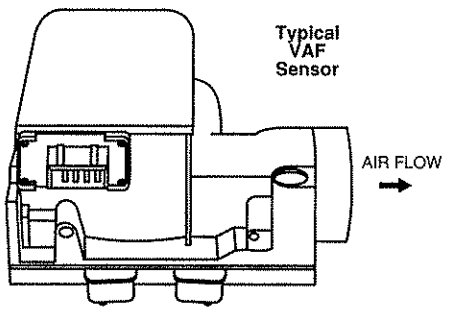
Signal values are low at idle. As engine RPM is gradually raised, signal values should increase steadily with no interruption. (Move throttle to check.) Change RANGE switch setting if necessary.

Note: Sensor is defective if signal jumps erratically when sensor GENTLY tapped with lightweight tool.

If signal is not operating correctly....

- *Check sensor power and ground circuits. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for airflow obstructions in ductwork, clogged air filter or air leaks around sensor or throttle body.*

Vane Air Flow (VAF) Sensor Test



This sensor sends a voltage signal to the computer indicating the amount of air entering the engine. The voltage level increases as the air flow increases. Used to control fuel delivery and spark advance.

This sensor uses a pivoting door ("vane") in the air path to measure flow.

• Refer to Section 2 for basic sensor test hook-up procedure.

• Sensor remains mounted on vehicle and connected to wiring harness for testing.

• Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS

6) Set RANGE switch to MED (5 volt scale).

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Start engine to operate sensor.

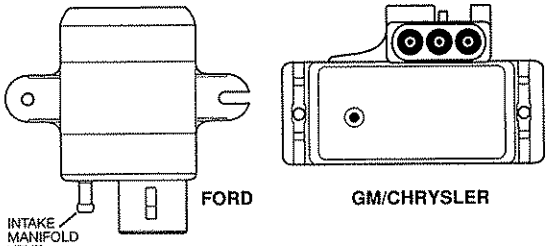
9) Watch tester displays to verify proper signal action.

Voltage level is low at idle. As engine RPM is gradually raised, voltage level should increase steadily with no interruption. (Move throttle to check.)

If signal is not operating correctly....

- *Check sensor power and ground circuits. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for airflow obstructions in ductwork, clogged air filter, binding pivot on vane "door" or air leaks around sensor or throttle body.*

Manifold Absolute Pressure (MAP) Sensor Test



Typical MAP Sensors

This sensor sends a signal to the computer indicating atmospheric pressure and/or engine vacuum. Depending upon sensor type, the signal may be a dc voltage or a frequency. More pressure (less vacuum) makes the sensor signal increase (higher voltage or frequency).

Used to control fuel delivery and spark advance. On turbocharged engines, the sensor is also used to monitor boost pressure and operate the wastegate accordingly.

This sensor uses an electronic module to measure pressure.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to desired signal type (VOLTS or FREQUENCY).

Refer to vehicle service manual for correct sensor signal type.

6) Set RANGE switch to proper scale (depends upon sensor).

Refer to vehicle service manual for correct signal operating range.

Typically, use MED for volts and LOW for frequency - change if necessary.

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Start engine to operate sensor.

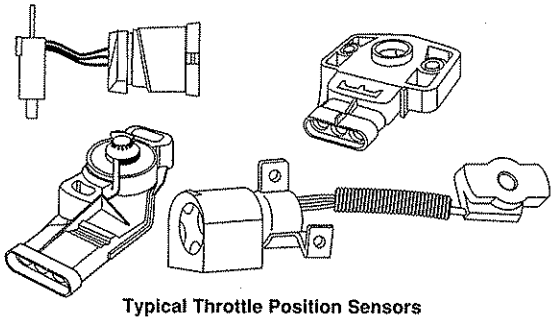
9) Watch tester displays to verify proper signal action.

Signal values are low at idle. Move throttle to vary engine RPM. Signal values should increase when engine vacuum decreases. Note: Signal values should be high when ignition key is ON and engine is OFF because manifold is at atmospheric pressure (no vacuum).

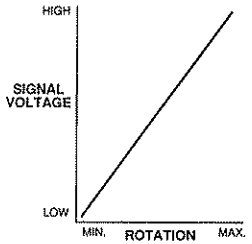
If signal is not operating correctly....

- *Check sensor power and ground circuits. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check MAP vacuum hose (is used) for correct hook-up, kinks, breaks or clogs.*

Throttle Position Sensor Test



Typical Throttle Position Sensors



Typical Operation

This sensor sends a voltage signal to the computer indicating throttle position (opening). The voltage signal changes as the throttle opens. Used to control idle speed, spark advance, fuel delivery, emission and electronic transmission systems.

The sensor consists of a potentiometer which is connected to the throttle shaft.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS.

6) Set RANGE switch to MED (5 volt scale).

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Turn ignition key ON (engine OFF).

9) Operate sensor and watch tester displays to verify proper signal action.

Slowly move throttle linkage back and forth from idle to wide open position. Voltage level should smoothly change up and down - without sudden jumps or dips. On most systems, the voltage increases as the throttle opens (other systems have decreasing voltage). Refer to vehicle service manual for correct signal operating range.

If signal is not operating correctly....

- *Check sensor power and ground circuits. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for misadjusted sensor mounting, binding throttle shaft / linkage or other components affecting throttle position (such as "Cruise Control" linkage problems, idle speed control motor, vacuum hose connected to throttle positioner, choke, or cam systems).*

Throttle Switch Test

An idle switch signals the computer when the throttle is in the idle position. Sometimes a second switch is used to signal a wide open throttle (or nearly so) condition. The switch sends a voltage signal which abruptly changes whenever the switch operates. Used to properly control air/fuel mixtures, spark advance, idle speed, and lock-up torque converters.

Throttle switches may be used alone, or along with throttle sensors - depends upon vehicle.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS.

6) Set RANGE switch to HIGH (15 volt scale).

Most switch circuits use battery voltage for power. Change RANGE to MED if the throttle switch circuit uses 5 volt power.

7) Connect red test lead clip to switch signal pin.

Refer to vehicle service manual for signal pin location.

8) Turn ignition key ON (engine OFF).

9) Operate sensor and watch tester displays to verify proper signal action.

Slowly move throttle linkage back and forth from idle to wide open position. Voltage level should change abruptly when the switch operates. Refer to vehicle service manual for correct signal action. The closed switch signal should be less than 0.2 volts. The open switch signal should be at a high (circuit power) voltage.

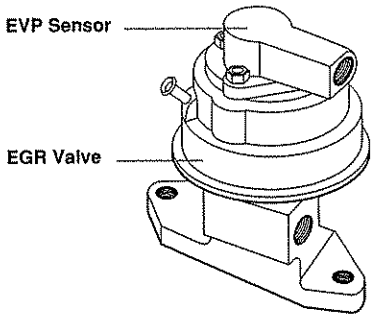
• *Idle position switch:* Normally closed (or open - depends upon vehicle) when the throttle is resting. The switch operates when the throttle is opened (by any amount) and no longer in the idle position.

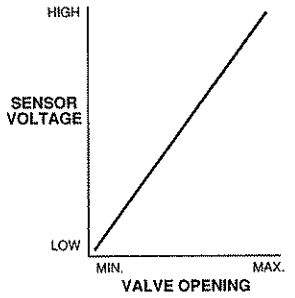
• *Wide Open Throttle switch (when used):* Normally open (or closed - depends upon vehicle) when the throttle is at idle or just partially open. The switch operates when the throttle is opened beyond a certain point. The amount of throttle opening required to operate the switch varies with vehicle.

If signal is not operating correctly....

- *Check switch ground circuit. Refer to Section 3.*
- *Check switch connectors for corrosion or damage.*
- *Check for misadjusted switch mounting, binding throttle shaft / linkage or other components affecting throttle position (such as "Cruise Control" linkage problems, idle speed control motor, vacuum hose connected to throttle positioner, choke, or cam systems).*

EGR Valve Position Sensor Test





This sensor sends a voltage signal to the computer indicating the amount of valve opening ("lift"). The voltage signal gets larger the more the valve is opened. Used to calculate EGR flow through the valve.

The sensor consists of a potentiometer which is mounted on top of the EGR valve. The sensor has an operating shaft which is pushed as the valve opens.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS.

6) Set RANGE switch to MED (5 volt scale).

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Turn ignition key ON (engine OFF).

9) Operate sensor and watch tester displays to verify proper signal action.

— Remove vacuum control hose from EGR valve.

— Connect hand vacuum pump to EGR valve.

— Gradually apply vacuum to slowly open valve.

Voltage level should smoothly increase as the valve is gradually opened - without sudden dips in value. Refer to vehicle service manual for correct signal operating range.

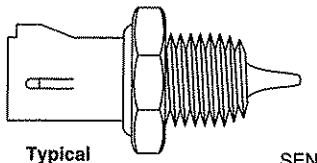
If signal is not operating correctly....

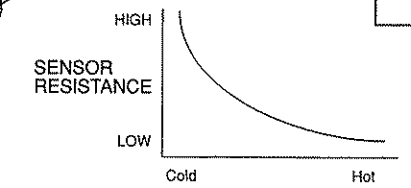
- *Check sensor power and ground circuits. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for damaged / sticking EGR valve or vacuum supply problems.*

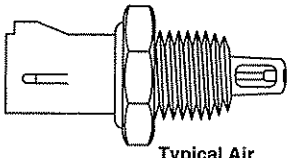
Temperature Sensor Test

— Engine Coolant Temperature Sensor *or...*

— Air Temperature Sensor







The computer uses *engine temperature* to modify air/fuel ratios, spark advance, idle speed, and emission device operation (such as an EGR valve).

The computer uses *air temperature* to calculate the amount of air entering the engine - for controlling fuel delivery.

The temperature sensor is a thermistor - a resister whose resistance changes with temperature. The hotter the sensor gets, the lower the resistance becomes.

The computer cannot measure the sensor resistance directly. Therefore, the sensor is connected into a circuit which develops a voltage across the sensor. This voltage changes when the sensor resistance changes and is easily measured by the computer.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS

6) Set RANGE switch to proper scale.

Refer to vehicle service manual for signal operating range. Most use MED (5 volt). The rest use HI.

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Start engine.

9) Watch tester displays to verify proper signal action.

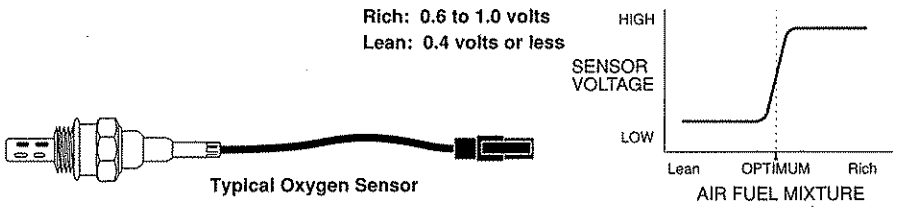
Note initial voltage level (it depends

on outside temperature and initial temperature of the engine). As the engine warms up, the voltage level should decrease steadily with no interruption. (The change is slow - it may take a few minutes of operation to notice a difference.) Refer to vehicle service manual for sensor voltages at various operating temperatures.

If signal is not operating correctly....

- *Check sensor ground circuit. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for heavy deposits on sensor tip (which can cause poor response) or engine running too hot (problems with antifreeze, thermostat, water pump, fan, belts, low engine oil). Engine temperature only: check for leakage into sensor housing. Air temperature only: check for restricted or blocked air passageways.*

Oxygen Sensor Test



Typical Oxygen Sensor

This sensor produces a voltage signal based on the amount of oxygen it contacts in the exhaust stream. A low voltage (less than 0.4V) indicates a lean exhaust (too much oxygen). A higher voltage (0.6 - 1.0V) signals a rich exhaust (not enough oxygen). The computer uses this sensor for fuel delivery - to create an optimum air/fuel mixture for low emissions and good fuel economy.

The sensor is a zirconium dioxide ceramic mounted in the tip of a threaded metal housing. The tip is perforated to protect the sensing element but still allow exhaust gases to pass through.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS

6) Set RANGE switch to LOW (1 volt scale).

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location. There may be extra wires for a sensor heating element or a ground.

8) Start engine - idle until warmed-up.

The sensor must be very hot to operate: 349C (660F).

9) Watch bar graph display to verify proper signal action.

— Both the engine and the sensor must be warmed-up.

— Sensor should switch between lean (less than 0.4V) and rich (0.6 - 1.0V) signal values. You may have to raise and hold the idle (at about 2000 RPM) to keep the sensor warmed-up and switching.

— Try the following if you do not see a switching signal. Starting at elevated (2000 RPM) idle, quickly release the throttle, then return to elevated idle. This throttle action can sometimes force the sensor to switch because of the momentary rich/lean engine condition. Repeat if necessary.

— A sensor that does not switch between the correct voltage levels *or* stays at a constant value *or* is slow ("lazy") in switching may be defective.

If signal is not operating correctly....

- *Check sensor ground circuit. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*
- *Check for contamination from fuel, oil additives, gasket sealer or an overly rich running engine. Factors which can make a rich running engine include: ignition system problems (coil, distributor cap, rotor, spark plugs, wires), fuel contaminated by engine oil, emission devices (carbon canister, EGR valve, PCV valve, air injection system), manifold leaks, air filter, fuel pressure and engine not at normal operating temperature.*

Power Steering Pressure Switch Test

This switch signals the computer when hydraulic pressure in the power steering system exceeds a certain amount - indicating that power steering is being used. The switch sends a voltage signal which abruptly changes whenever the switch operates. Used to increase idle speed and prevent engine stumble when power steering is being used.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS.

6) Set RANGE switch to HIGH (15 volt scale).

Most switch circuits use battery voltage for power. Change RANGE to MED if the switch circuit uses 5 volt power.

7) Connect red test lead clip to switch signal pin.

Refer to vehicle service manual for signal pin location.

8) Start engine.

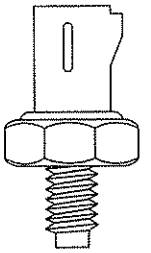
9) Operate switch and watch tester displays to verify proper signal action.

Rotate steering wheel to activate switch. Voltage level should change abruptly when the switch operates. Refer to vehicle service manual for correct signal action. (Switch may be normally closed or open - depends upon vehicle.) Release steering wheel to deactivate switch. The closed switch signal should be less than 0.2 volts. The open switch signal should be at a high (circuit power) voltage.

If signal is not operating correctly....

- *Check switch ground circuit. Refer to Section 3.*
- *Check switch connectors for corrosion or damage.*

Knock Sensor Test



Typical Knock Sensor

This sensor sends a small AC voltage signal to the computer during engine knock conditions. The signal level increases as the knock gets more severe. The computer retards spark timing when a knock signal is received.

The knock sensor contains a piece of piezo-electric material. This acts like a microphone - it changes vibrations into a small AC voltage signal.

- *Refer to Section 2 for basic sensor test hook-up procedure.*
- *Sensor remains mounted on vehicle and connected to wiring harness for testing.*
- *Make connections using backprobe adapter if possible. Otherwise, carefully pierce wire with appropriate tool. Be sure to cover hole in wire insulation with suitable adhesive sealant after testing.*

1) Turn ignition key OFF.

2) Connect tester power cable to vehicle battery.

3) Plug red test lead into tester INPUT jack.

4) Set DISPLAY switch to INPUT.

5) Set other DISPLAY switch to VOLTS.

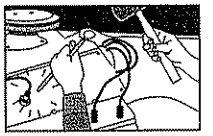
6) Set RANGE switch to LOW (1 volt scale).

7) Connect red test lead clip to sensor signal pin.

Refer to vehicle service manual for signal pin location.

8) Turn ignition key ON (engine OFF).

9) Operate sensor and watch tester displays to verify proper signal action.



— *Lightly* tap surface near sensor using a socket extension (or similar tool) and a light hammer. ***Do not tap directly on sensor!***

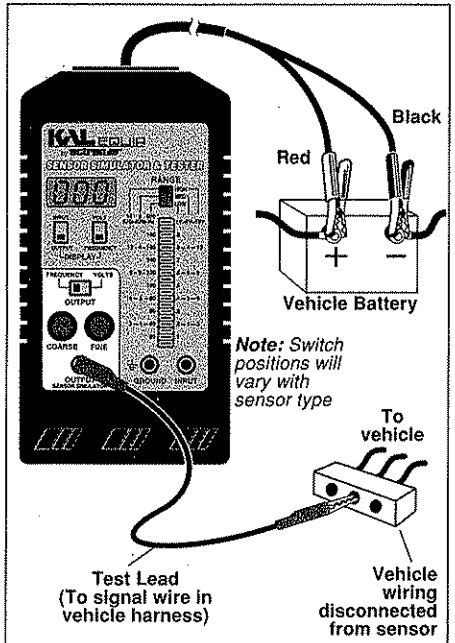
— Watch the bar graph display. The light should flash upward from the bottom of the display column during a tap. (Only a few lights may flash. This is O.K.) Range of light movement varies with sensor type and tapping force.

If signal is not operating correctly....

- *Check sensor ground circuit. Refer to Section 3.*
- *Check sensor connectors for corrosion or damage.*

Section 4
Basic Sensor Simulation Hook-Up Procedure

The following is a basic procedure for simulating sensor signals - dc voltage or frequency.



Typical connection shown.
Refer to vehicle service manual for:
- Sensor signal type
- Sensor signal pin location

1) **Turn ignition key OFF.**

2) **Connect tester power cable to vehicle battery.**

   Red clamp to battery plus terminal and black clamp to battery minus terminal.

3) **Plug red test lead into tester OUTPUT jack.**

   No other leads are required. (The power cable provides ground for simulator signals.)

4) **Set OUTPUT switch to desired signal type (VOLTS or FREQUENCY).**

   Refer to vehicle service manual for correct sensor signal type.

5) **Set DISPLAY switch to OUTPUT.**

   Only the numeric display is active. (Bar graph is turned off.)

6) **Set other DISPLAY switch to same position as OUTPUT switch (VOLTS or FREQUENCY)**

   The display must be properly set-up to indicate the output signal correctly.

7) **Disconnect vehicle wiring harness from sensor.**

8) **Connect red test lead clip to sensor signal wire in vehicle harness.**

   Refer to vehicle service manual for signal wire location.

9) **Adjust OUTPUT signal using COARSE, FINE and RANGE controls.**

   Refer to vehicle service manual for appropriate sensor signal level.

   Use COARSE and FINE controls to adjust signal within the following *approximate* RANGE settings:

   LOW - 0 to 1.25 volt *or* 0 to 160 Hz.

   MED - 0 to 2.5 volts *or* 0 to 5 KHz.

   HIGH - 0 to 5 volts *or* 0 to 15 KHz.

10) **Turn ignition key ON (engine OFF). Readjust output settings if necessary.**

    Readjustments may be needed due to vehicle characteristics - usually when simulating temperature sensor signals. This is normal.

11) **Verify sensor signal is reaching engine computer.**

    Check for wiring problems if computer does not receive signal.

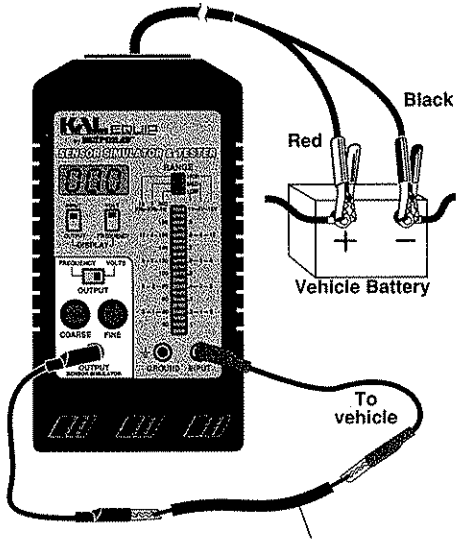
— Use a scan tool to read the simulated sensor signal as received by the computer, *OR*...

— Start engine and verify engine response is appropriate for the sensor signal being sent. For example, cooling fan turning on because of a simulated "hot engine" sensor signal. (Very often, idle speed will also change when a simulated throttle position *or* engine temperature sensor signal is varied.)

Note that engine computers may be programmed to ignore sensor signals judged to be abnormal or behaving incorrectly. Thus, if you send a "bad" sensor signal the computer may disregard it, but a trouble code will usually be set.

Section 5
Testing Wires for Opens and Shorts

The following is a basic procedure for checking vehicle wiring using the tester.



Note: Switch positions will vary during test. Follow all steps!

1) Turn ignition key OFF.

2) Disconnect both ends of the wire under test.

Wire must be completely disconnected from any other circuit.

3) Set tester to <u>send</u> 4 volts:

Connect tester power cable to vehicle battery.

OUTPUT switch on VOLTS.

DISPLAY switches on OUTPUT and VOLTS.

RANGE switch on HIGH.

Adjust COARSE and FINE controls for 4 volt output.

4) Connect black test lead between OUTPUT jack and one end of wire.

5) Check display for short circuit condition.

If the display shows zero volts, the wire is shorted to vehicle ground. (This will not harm the tester.)

6) Set tester to measure 4 volts:

(Do not move OUTPUT, COARSE or FINE controls.)

DISPLAY switches on INPUT and VOLTS.

RANGE switch on MED.

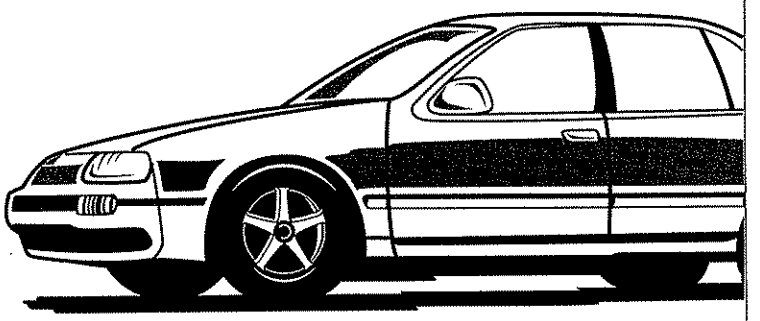
7) Connect red test lead between INPUT jack and other end of wire.

8) Check display for voltage:

— 4 volts means the wire is continuous.

— Less than 4 volts means excessive resistance (such as from corrosion on wire or connector).

— Zero volts means the wire is completely open.



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